DESCRIPTION

GAS REPLACEMENT METHOD OF FUEL CELL, FUEL CELL SYSTEM AND DEVICE FOR FUEL CELL SYSTEM

TECHNICAL FIELD

The present invention relates to a gas replacement method of a fuel cell system using gas such as hydrogen as a fuel, and particularly relates to a gas replacement method, a fuel cell system and a device for the fuel cell system, which replace gas other than fuel in the fuel cell system with the fuel to fill an inside of the fuel cell system with the fuel which is supplied from a fuel cartridge.

BACKGROUND ART

In recent years, environmental destruction has become a problem, and a clean energy which does not generate harmful waste is required. Exhaustion of fossil fuel also becomes a problem, and a new energy source is in demand. Meanwhile, in the electronics field, the amount of information increases, with which the information processing ability is dramatically enlarged, and electric power consumption of electronic equipments tends to increase.

Thus, hydrogen, which is contained in water that is inexhaustible on the earth, has a large

chemical energy, and does not discharge harmful substances, attracts attention as an energy source. A fuel cell, which directly produces an electric energy, can take out a large amount of electric power with highly efficient use of hydrogen, and therefore, application to automobiles and portable electronic devices such as notebook computers, mobile phones and digital camcorders is being advanced.

A so-called fuel cell, which takes out an electric energy from hydrogen, has a hydrogen electrode to which hydrogen is supplied and an oxidation electrode to which oxygen is supplied, separates hydrogen atoms into electrons and protons by a catalytic reaction in the hydrogen electrode, and the protons pass through an electrolyte membrane, then reach the oxidation electrode, and react with oxygen by a catalytic reaction, whereby water generates, and in this process, the flow of electrons, namely electric power, is generated.

Unlike the conventional batteries, in the fuel cell, there is no need of electric charge, and it is possible to generate electric power immediately by only replenishing it with fuel after the fuel is used up, which is convenient for long-term use of a device.

A fuel cell system that supplies fuel into the fuel cell system from a fuel cartridge is described, for example, in Japanese Patent Application Laid-open

No. 2002-158022.

DISCLOSURE OF THE INVENTION

As described above, the fuel cell can take out an electric energy by replenishing it with a fuel at any time at any place, but has to use gas such as hydrogen unlike the conventional secondary battery.

On replacement of a fuel cartridge, it is necessary to remove the fuel cartridge from a fuel cell system temporarily, and on this occasion, air in the atmosphere will enter the fuel cell system. At that time, the output of the fuel cell significantly reduces, or in many cases, the reaction of the fuel cell stops. Accordingly, it is essential to replace the gas inside the fuel cell system with fuel gas at the time of fuel replacement.

In addition to the time of replacement of a fuel cartridge, gas replacement is also necessary when any gas other than fuel gas enters a fuel cell system.

When a fuel cell system is not of a cartridge type, but is provided integrally with a fuel tank, there is a possibility that any gas other than a fuel may enter the fuel cell system.

The present invention has been accomplished in view of such background art, and it is, therefore, an object of the present invention to provide a simpler

gas replacement method, fuel cell system and device for the fuel cell system to replace gas other than fuel, which enters the fuel cell system that is supplied with a fuel from a fuel cartridge or a fuel tank provided in the fuel cell system, with fuel gas. In particular, the present invention provides an automatic gas replacement method, fuel cell system and a device for the fuel cell system, by which the user does not need to perform gas replacement operation manually.

Namely, according to a first aspect of the present invention, there is provided a method of replacing gas in a fuel cell system, comprising the steps of:

detecting that a fuel cartridge is connected to a fuel cell system comprising a fuel cell; and

supplying a fuel from the fuel cartridge on the basis of the detection to start replacement of gas in the fuel cell system.

In the present invention, it is preferred that the gas replacement is performed for a predetermined period of time.

Further, it is preferred that the gas in the fuel cell system is discharged from a purge valve provided in the fuel cell system based on the detection.

Moreover, it is preferred that the replacement

of the gas in the fuel cell system is performed until an output voltage of the fuel cell becomes a predetermined value or more.

According to a second aspect of the present invention, there is provided a method of replacing gas in a fuel cell system, comprising the steps of:

detecting an output voltage of a fuel cell provided in a fuel cell system; and

when the output voltage becomes a predetermined value or less, supplying a fuel from a fuel cartridge to start replacement of gas in the fuel cell system.

It is preferable to perform the replacement of the gas in the fuel cell system until the output voltage of the fuel cell becomes a predetermined value or more.

According to a third aspect of the present invention, there is provided a method of replacing gas in a fuel cell system, comprising the steps of:

detecting an output voltage of a fuel cell provided in a fuel cell system; and

when the output voltage becomes a predetermined value or less, supplying a fuel from a fuel tank provided in the fuel cell system to start replacement of gas in the fuel cell system.

It is preferable to perform the replacement of the gas in the fuel cell system until the output voltage of the fuel cell becomes a predetermined

value or more.

According to a fourth aspect of the present invention, there is provided a method of replacing gas in a fuel cell system attached to a device, comprising the step of, when a switch of a device to which a fuel cell system is attached is turned on, supplying a fuel from a fuel cartridge to start replacement of gas in the fuel cell system.

It is preferred that the switch is a power source switch of the device.

According to a fifth aspect of the present invention, there is provided a method of replacing gas in a fuel cell system attached to a device, comprising the step of, when a switch of a device to which a fuel cell system is attached is turned on, supplying a fuel from a fuel tank provided in the fuel cell system to start replacement of gas in the fuel cell system.

According to a sixth aspect of the present invention, there is provided a fuel cell system, comprising:

a fuel cell;

a connecting part for connecting a fuel cartridge; and

a sensor for detecting that the fuel cartridge is connected to the connecting part,

wherein a fuel is supplied from the fuel

cartridge connected to the connecting part on the basis of the detection by the sensor to start replacement of gas in the fuel cell system.

According to a seventh aspect of the present invention, there is provided a fuel cell system, comprising:

a fuel cell;

a connecting part for connecting a fuel cartridge; and

a voltage detector for detecting an output voltage of the fuel cell,

wherein when the output voltage detected by the voltage detector becomes a first predetermined value or less, a fuel is supplied from the fuel cartridge connected to the connecting part to start replacement of gas in the fuel cell system.

According to an eighth aspect of the present invention, there is provided a fuel cell system, comprising:

a fuel cell;

a fuel tank; and

a voltage detector for detecting an output voltage of the fuel cell,

wherein when the output voltage detected by the voltage detector becomes a first predetermined value or less, a fuel is supplied from the fuel tank to start replacement of gas in the fuel cell system.

According to a ninth aspect of the present invention, there is provided a device for a fuel cell system, comprising:

an attaching part for attaching a fuel cell system; and

a switch provided in the device,

wherein a fuel is supplied from a fuel cartridge connected to the fuel cell system in response to turn-on of the switch to start replacement of gas in the fuel cell system.

According to a tenth aspect of the present invention, there is provided a device for a fuel cell system, comprising:

a fuel cell system comprising a fuel cell and a connecting part for connecting a fuel cartridge; and

a switch provided in the device,

wherein a fuel is supplied from the fuel cartridge connected to the fuel cell system in response to turn-on of the switch to start replacement of gas in the fuel cell system.

According to an eleventh aspect of the present invention, there is provided a device for a fuel cell system, comprising:

a fuel cell system comprising a fuel cell and a fuel tank; and

a switch provided in the device,

wherein a fuel is supplied from the fuel tank

of the fuel cell system in response to turn-on of the switch to start replacement of gas in the fuel cell system.

With the gas replacement method of a fuel cell system, the fuel cell system and the device for a fuel cell system in accordance with the present invention, it is possible to replace gas other than a fuel, which has entered a fuel cell that is supplied with the fuel from a fuel cartridge or a fuel tank provided in the fuel cell system, with the fuel gas more easily. Especially, the user does not have to perform the gas replacement operation manually, but the gas replacement can be automatically performed to actuate the fuel cell.

Other features and advantages of the present invention will be apparent from the following description taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a central sectional view of a main part of a fuel cell system for explaining a preferred embodiment of the gas replacement method of the fuel cell system in accordance with the present invention;

FIG. 2 is a perspective view showing the appearance of a fuel cell system and a fuel cartridge;

FIG. 3 is a perspective view showing the fuel cartridge part of FIG. 2;

FIG. 4 is a block diagram for explaining the present invention;

FIG. 5 is a diagram showing a flow chart explaining an operation according to a preferred embodiment of the present invention;

FIG. 6 is a diagram showing a flow chart explaining an operation according to a preferred embodiment of the present invention;

FIG. 7 is a diagram showing a flow chart explaining an operation according to a preferred embodiment of the present invention;

FIG. 8 is a diagram showing a flow chart explaining an operation according to a preferred embodiment of the present invention;

FIG. 9 is a schematic perspective view showing a digital camera using the fuel cell system according to the present invention;

FIG. 10 is a schematic perspective view showing the rear surface and bottom surface of the digital camera of FIG. 9; and

FIG. 11 is a schematic perspective view showing the state in which the fuel cell system and fuel cell cartridge of the present invention are attached to the digital camera shown in FIG. 10.

BEST MODE FOR CARRYING OUT THE INVENTION

The gas replacement method of a fuel cell of the present invention is a method of replacing gas in a fuel cell system, which comprises detecting that a fuel cartridge is connected to a fuel cell system comprising a fuel cell and supplying a fuel from the fuel cartridge on the basis of the detection to start replacement of gas in the fuel cell system.

Further, the gas replacement method of a fuel cell of the present invention is a method of replacing gas in a fuel cell system, which comprises detecting an output voltage of a fuel cell provided in a fuel cell system, and when the output voltage becomes a predetermined value or less, supplying a fuel from a fuel cartridge to start replacement of gas in the fuel cell system.

Moreover, the gas replacement method of a fuel cell of the present invention is a method of replacing gas in a fuel cell system, which comprises detecting an output voltage of a fuel cell provided in a fuel cell system, and when the output voltage becomes a predetermined value or less, supplying a fuel from a fuel tank provided in the fuel cell system to start replacement of gas in the fuel cell system.

Further, the gas replacement method of a fuel cell of the present invention is a method of

replacing gas in a fuel cell system attached to a device, which comprises, when a switch of a device to which a fuel cell system is attached is turned on, supplying a fuel from a fuel cartridge to start replacement of gas in the fuel cell system.

Moreover, the gas replacement method of a fuel cell of the present invention is a method of replacing gas in a fuel cell system attached to a device, which comprises, when a switch of a device to which a fuel cell system is attached is turned on, supplying a fuel from a fuel tank provided in the fuel cell system to start replacement of gas in the fuel cell system.

In the above-described gas replacement methods of the fuel cell in accordance with the present invention, it is preferable to perform the replacement of the gas in the fuel cell system until the output voltage of the fuel cell of the fuel cell system becomes a predetermined value or more.

In the present invention, as described above, it is detected that the fuel cartridge is connected to the fuel cell system, and the gas replacement operation can be performed automatically. Alternatively, the output of the fuel cell is detected, and the gas replacement can be performed when a predetermined voltage is not produced. Alternatively, the gas replacement can be performed

in synchronization with turn-on of a switch of a portable electronic device, for example, a personal computer, a mobile phone, a digital camera, or digital camcorder. It is especially preferable to synchronize the gas replacement with turn-on of a main switch of such a portable electronic device. For example, in most devices, a main switch will be a main power source switch.

Preferred embodiments of the present invention will be described with reference to the drawings.

FIG. 1 is a central sectional view showing a main part of a fuel cell system and a fuel cartridge showing a preferred embodiment of the present invention. FIG. 2 is a perspective view showing the state in which a fuel cell system 1 and a fuel cartridge 2 are connected to each other. The fuel cell system 1 is contained in a portable electronic device, for example, a digital camera in this embodiment. The fuel cell system 1 may be constructed to be detachable from the portable device. The fuel cartridge 2 is capable of being inserted from an outside of the digital camera. FIG. 3 is a perspective view showing the fuel cartridge. Reference numeral 3 denotes a cartridge casing, and it may be filled with compressed hydrogen, or may have a construction in which a hydrogen storage alloy such as, for example, Fe-Ti alloy and Ti-Mn alloy are

made to occlude hydrogen. Reference numeral 3a denotes a cover member that will be described in detail later, and reference numeral 4b denotes a protruding part of a valve.

In FIG. 1, reference numeral 6 denotes a casing of the fuel cell system. Reference numeral and character 6a denotes a recessed part (namely, the recessed part 6a is a connecting part on the fuel cell system side to which the connecting part of the fuel cartridge is connected), into which the connecting part of the fuel cartridge is inserted. Reference numeral and character 3a denotes the cover member, which is disposed around the protruding part 4b of a valve 4, and a protruding part thereof is larger than the protruding part 4b. A circular conical surface 4a of the valve 4 is in contact with a circular conical surface 3b of the fuel cartridge so that the fuel gas does not leak outside. Reference numeral 5 denotes a compression spring of which right end portion in the drawing is fixed to a member (not shown) inside the fuel cartridge, and of which left end portion presses a bottom surface 4c of the valve 4. Namely, hydrogen gas pressure and a force of the compression spring 5 bring the circular conical surfaces 3b and 4a into contact with each other so that the hydrogen gas does not leak outside the fuel cartridge.

The valve 4 and the cover member 3a in the drawing are made smaller as compared with a finger of a child, and are formed in such size as to prevent a finger of a child from reaching the protruding part 4b of the valve 4 in a hole 3c of the cover member.

Reference numeral and character 6a denotes the recessed part, in which a V-shaped groove 6c is formed, and an O-ring 7 as a seal member is disposed therein. Reference numeral and character 3g denotes a screw part provided at the cover member 3a.

Next, an operation will be explained based on FIG. 1.

When the fuel cartridge 2 is inserted, a chamfered portion 3e formed at a tip end portion of the cover member 3a abuts to the seal member 7, and the cover member 3a moves in the leftward direction in FIG. 1 while compressing the seal member 7. The seal member 7 is in close contact with an outer surface 3d of the cover member 3a to make a fuel flow path airtight.

Reference numeral and character 6d denotes a screw part provided at the recessed portion 6a. After the seal member 7 is compressed by the recessed part 6a and the cover member 3a and air-tightness of the fuel flow path is secured, the screws 3g and 6d are engaged with each other to screw the casing 3 of the fuel cartridge into the casing 6 of the fuel cell

system, whereby the valve 4 and a pin 8 abut to each other, and the fuel cartridge 2 is further inserted into the recessed part 6a against the fuel gas pressure and the force of the compression spring 5, thus releasing the contact between the circular conical surfaces 3b and 4a and supplying hydrogenl gas to the fuel cell system 1 from the inside of the casing 3 of the fuel cartridge.

A surface 3f of the casing 3 of the fuel cartridge and a surface 6b of the casing 6 of the fuel cell system abut to each other to complete insertion, and the fuel cell system 1 and the fuel cartridge 2 are fixed to each other.

Reference numeral 9 denotes a diaphragm, which has a disc shape, and an outer peripheral part 9a is fixed to a casing 10 of a regulator body. The casing 10 is fixed to a fixed member (not shown) inside the casing 6. The diaphragm 9 has a pin 8 fixed to a plane part 9b in the center, has a corrugated recesses and protrusions formed concentrically, has a spring characteristic, and receives hydrogen pressure at the right side in the drawing and gas pressure of the inside of the casing 10. The diaphragm 9 is freely displaceable in the left and right direction in the drawing in accordance with the change in the hydrogen gas pressure.

A right end portion in the drawing of the pin 8

is a spherical surface 8a, which is made abut to the protruding part 4b of the valve 4. Reference numeral 11 denotes a compression spring, one end of which is fixed to the inside of the casing 10 and the other end of which is fixed to a surface opposite to the pin, of the plane part 9b of the diaphragm 9 having the pin fixed thereto.

Next, an operation will be explained. When the casing 3 of the fuel cartridge is inserted, and is screwed in with the screw parts 3g and 6d are engaged with each other, and the surfaces 3f and 6b abut to each other, the hydrogen gas pressure inside the fuel cartridge and the compression spring 5 exert a force in the leftward direction in the drawing. The gas pressure inside the casing 10 of the diaphragm and the compression spring 11 exert a force in the rightward direction in the drawing. The gas pressure inside the casing 6 of the fuel cell system exerts a force in the leftward direction in the drawing to the diaphragm 9. The resultant force of these forces determines the positions of the pin 8 and the valve 4. Namely, when the hydrogen gas pressure inside the casing 6 of the fuel cell system is at a predetermined value, the circular conical surface 4a of the valve 4 and the circular conical surface 3b of the fuel cartridge abut to each other and flow of the hydrogen gas into the fuel cell system side from the

fuel cartridge side is stopped.

When the hydrogen gas is consumed during the power generation of the fuel cell reaction, the hydrogen gas pressure inside the casing 6 of the fuel cell system reduces, so that the diaphragm 9 is displaced in the rightward direction in the drawing. As a result, the pin 8 presses the valve 4 in the rightward direction in the drawing to displace it, whereby the contact of the circular conical surfaces 4a and 3b is released, and the hydrogen gas inside the casing 3 of the fuel cartridge flows into the fuel cell system side.

As explained above, the outer peripheral part of the diaphragm is fixed to the casing 10 of the regulator and is therefore not given the influence of the ambient air pressure. Accordingly, by properly setting the gas pressure inside the casing 10 of the regulator and the force of the compression spring 11, a desired hydrogen gas pressure can be maintained. Alternatively, without using the compression spring shown in this embodiment, by only setting the gas pressure inside the casing 10 of the regulator suitably, it is possible to obtain the desired hydrogen gas pressure.

Reference numeral 12 denotes a sensor for detecting that the fuel cartridge is connected to the connecting part of the fuel cell system side. In

this example, reference numeral 12 denotes a micro switch, and is disposed so as to be turned on just before the fuel cartridge is fixed to the fuel cell system. Reference numeral 13 denotes a purge valve that performs gas replacement, and a circular conical surface 13a thereof abuts to a circular conical surface 6e formed at the casing 6 of the fuel cell system. Reference numeral 14 denotes a compression spring, which biases the purge valve 13 in the upward direction in the drawing. The compression spring 14 always keeps the circular conical surfaces 13a and 6e in contact with each other, so that the gas inside the fuel cell system does not leak outside. Reference numeral 15 is an electromagnet. By energizing two lead wires 15b, a plunger 15a displaces in the downward direction in the drawing against the force of the compression spring 14 to release contact between the circular conical surfaces 13a and 6e so that the gas inside the fuel cell system flows outside.

FIG. 4 is a block diagram according to the present invention.

In the figure, reference numeral 12 denotes the switch shown in FIG. 1, and reference numeral 15 denotes the electromagnet shown in FIG. 1. Reference numeral 16 is a microcomputer as control means inside a device where the fuel cell system body is disposed,

in this embodiment, a digital camera, and reference numeral 17 denotes a main switch of the digital camera. Reference numeral 18 denotes a power source in the digital camera, which is used for actuation or the like of the fuel cell. Reference numeral 19 denotes a fuel cell output voltage detecting part.

Next, an operation will be explained. As is seen from FIG. 1, when the fuel cartridge is attached, the ambient air enters from the hole 6a of the casing 6 of the fuel cell system. In this state, the reaction of the fuel cell does not advance. Just before completion of attaching the fuel cartridge, the switch 12 is turned on, and the signal is inputted into the microcomputer 16. The microcomputer 16 energizes the electromagnet 15 for a predetermined period of time to open the purge valve 13, whereby the gas inside the fuel cell system is discharged outside and the pressure inside the fuel cell system lowers, and therefore the fuel gas is supplied from the fuel cartridge, as a result of which, the gas inside the fuel cell system is replaced with the fuel gas. In this case, the point to be noted is that unless the gas pressure inside the fuel cell system is higher than the atmospheric pressure, the replacement of gas will not occur, and the ambient air will enter the system instead. Accordingly, in this embodiment, the gas pressure

inside the fuel cell system has to be necessarily set to be higher than the atmospheric pressure.

Instead of purging the gas inside the fuel cell system to the atmosphere by the purge valve, the gas may be recovered by a recovering tank, for example.

FIG. 5 is a flow chart for explaining the operation.

Explanation will be made based on this flow chart.

Even when the main switch 17 of the digital camera of FIG. 4 is in OFF state, the microcomputer 16 operates and performs the detection of attachment/detachment of the fuel cartridge.

The microcomputer 16 detects the state of the switch 12 (101), and in ON state, the microcomputer 16 performs the loop and continues the detection of the switch 12.

When the microcomputer 16 detects OFF of the switch 12 (101), it performs the loop and continues the detection until the switch 12 is turned ON (102). Because turn-on of the switch 12 means that the fuel cartridge is attached, the program jumps to the next step, where the electromagnet is energized for a predetermined period of time (103) to replace the gas.

Accordingly, without a special operation of the user, the gas replacement is automatically performed. Next, the program returns to the start, and the above

operation is repeated.

FIG. 6 is a flow chart for explaining another embodiment.

In this embodiment, the operation of the fuel cell output detection part 19 shown in FIG. 4 is added to the flow chart shown in FIG. 5. After the program proceeds to the step 103 in the flow chart in FIG. 5, the fuel cell output voltage detection part 19 detects the voltage (104), and when the voltage is less than a predetermined value, it is determined that the gas replacement is insufficient and the program returns to the step 103, where the electromagnet 15 is energized for the predetermined period of time, the purge valve opens, and the gas replacement is performed. When it is determined that the voltage is the predetermined value or more (104), the series of operation is finished and the program returns to the start, and the operation of the flow chart is continued.

The operation of the above flow charts in FIGS. 5 and 6 can be performed only when the digital camera main switch 17 is in ON sate. In this case, consumption of the power source 18 in the digital camera can be reduced.

Next, still another embodiment will be explained. A digital camera involved in this embodiment detects the voltage in the fuel cell

output voltage detection part 19 when the main switch 17 is in ON state, and when the voltage becomes a first value or less, it opens the purge valve 13 for a predetermined time and performs gas replacement.

Alternatively, until the voltage detected in the fuel cell output voltage detection part 19 becomes a second predetermined value or more, the purge valve 13 is opened.

The first predetermined value and the second predetermined value may be properly determined depending on the characteristics of the fuel cell, and may be set at different values or the same value depending on the characteristics.

FIG. 7 is a flow chart for explanation. The explanation will be made based on this flow chart. At the time of operation of a digital camera, the fuel cell output voltage detection part 19 detects the voltage at all times or at predetermined time intervals, and determines whether the voltage is less than the predetermined value (201). When the voltage is the predetermined value or more, the voltage detection is continued. When the voltage is less than the predetermined value, the program jumps to the next step, and the electromagnet 15 is energized for a predetermined period of time (202), whereby the purge valve 13 is opened and gas replacement is performed. Thereafter, the fuel cell output voltage

detection part 19 detects the voltage and determines whether the voltage is not less than the predetermined value (203). When the voltage does not reach the predetermined value, the gas replacement is insufficient, and the program returns to step (202), where the electromagnet 15 is energized for the predetermined period of time and the gas replacement is performed. Thereafter, it is determined whether the voltage is not less than the predetermined value (203), and when the voltage is the predetermined value or more, the program returns to the start, and the same procedure is repeated.

Accordingly, it is possible to operate the fuel cell stably without a special operation of the user.

Next, still another embodiment will be explained. In this embodiment, whenever the main switch 17 of the digital camera is turned ON, the electromagnet 15 is energized for a predetermined period of time, whereby the purge valve 13 is opened and the gas replacement is performed.

FIG. 8 is a flow chart for explanation. The explanation will be made based on this flow chart. When the digital camera main switch 17 is turned ON (301), the electromagnet 15 is energized for a predetermined period of time (302) and the purge valve 13 is opened, whereby the gas replacement is performed. Thereafter, the fuel cell output voltage

detection part 19 detects the voltage and determines whether the voltage is not less than the predetermined value (303). When the voltage is less than the predetermined value, the gas replacement is insufficient, and therefore, the program returns to step (302), where the electromagnet 15 is energized for the predetermined period of time, and gas replacement is performed. Thereafter, it is determined whether the voltage is not less than the predetermined value (303), and when the voltage is the predetermined value or more, the procedure is finished.

According to this embodiment, without the awareness of the user, the fuel cell is normally operated. In this embodiment, detection of the fuel cell output voltage may not be necessarily performed, and the electromagnet 15 may be only energized for the predetermined time.

FIG. 9 is a perspective view showing a digital camera as one example of a device using the fuel cell system according to the present invention. In the figure, reference numeral 91 denotes a camera body, reference numeral 92 denotes a taking lens, and reference numeral 93 denotes a main switch, which is linked to the digital camera switch 17 shown FIG. 4.

FIG. 10 is a schematic perspective view showing the rear and bottom surfaces of the digital camera

shown in FIG. 9. FIG. 11 is a schematic view showing a state in which the fuel cell system and the fuel cell cartridge of the present invention are attached to the digital camera shown in FIG. 10. Reference numeral 95 denotes a lid of an attaching part 96, and reference numeral 96 denotes the attaching part (also referred to as "cell housing chamber") for housing the fuel cell system, reference numeral 97 denotes an operation switch for operating the digital camera, and reference numeral 98 is a liquid crystal screen for a view finder of the digital camera, and for reviewing taken images, and the like.

In this embodiment, as the switch which is synchronized with the gas replacement operation, the main switch 93 is taken as an example, but in the respect that the gas replacement of the fuel cell system is operated on the side of the device such as a digital camera, the operation switch 97 other than the main switch 93 may be used. Namely, the gas replacement may be controlled by the operation of the operation switch 97 on the device side. Of course, when the main switch such as the power source switch of the device is synchronized with the gas replacement, the replacement can be performed more easily because the main switch is the first switch to be operated when the device is used in many cases. Namely, in the respect that the user does not need to

perform gas replacement operation manually, gas replacement can be automatically performed and the fuel cell can be actuated, it is preferable that the switch synchronized with the gas replacement operation is made the main switch.

In this example, the case of the fuel cartridge type is explained, but instead of the fuel cartridge, the present invention can suitably be applied to the case in which the fuel cell system is provided integrally with a fuel tank. Namely, the gas replacement may be performed depending on the output voltage of the fuel cell, or the gas replacement may be performed corresponding to turn-on of the switch on the device side (especially, the main switch).

In this embodiment, the case of using the microcomputer provided in the digital camera as the control means for gas replacement has been explained, but the control means may be provided on the fuel cell system side and the gas replacement may be controlled by this control means.

Industrial Applicability

With the gas replacement method of a fuel cell, the fuel cell system and the device for the fuel cell system, it is possible to more easily replace gas other than the fuel, which enters the fuel cell that is supplied with the fuel from a fuel cartridge or a

fuel tank provided in the fuel cell system, with the fuel gas. Especially, the user does not need to perform the gas replacement operation manually, the gas replacement is performed automatically and the fuel cell can be actuated. The present invention can be applied to a fuel cell system used for automobiles, portable electronic devices such as notebook computers, mobile phones and digital camcorders.

This application claims priority from Japanese Patent Application No. 2003-402841 filed December 2, 2003, which is hereby incorporated by reference herein.